Department of Energy
Office of Science
Washington, DC 20585

Office of the Director

April 21, 2004

Dr. Keith O. Hodgson
Director, Stanford Synchrotron Radiation Laboratory
Department of Chemistry
Stanford University
Stanford, CA 94305

Dear Dr. Hodgson:

Patients with neurological impairments such as blindness, deafness, and paralysis have little hope of recovery to a more normal, productive life with present medical treatments. Over the past twenty years there has been considerable research on electronic devices that interface with the nervous system to restore the neurological deficit in these patients. With the exception of the partial success of the artificial cochlear and initial successes of the artificial retina, intractable problems of design, sub-optimal materials, and faulty microelectronics have inhibited progress in this field. The DOE National Laboratories with their unsurpassed expertise in material sciences, MEMS (micro electrical mechanical systems) and micro fabrication, microelectronics and computational modeling are in a unique position to construct intelligent micro-machines that can both sense and correctly stimulate the nervous system to correct these devastating disabilities.

The Office of Biological and Environmental Research (BER) has achieved considerable success in the neurosciences, particularly in the field of neuroimaging and more recently in developing proto-type devices to restore vision (artificial retina).

For example, the modern era of brain research has been facilitated by BER's development of radiopharmaceuticals that localize to specific anatomic and biochemical pathways in the brain, the positron emission tomography (PET) scanner, and complex computational algorithms for rapid processing of data that generate three-dimensional images of brain function.

In addition, BER embarked on a program utilizing the scientific strengths and personnel of six DOE National Laboratories (ORNL, LANL, LLNL, LBNL, ANL, and SNL), together with industrial and academic partners, to construct a small device (artificial retina) that can be implanted in the back of the eye to replace damaged retinal photoreceptive cells. Visual signals are captured by a small video camera in the eyeglasses of the blind person and sent to the intraocular device. The artificial retina converts the light signal into spatially correct electrical impulses, produced by a multi-array of stimulating electrodes, which are carried via the optic nerve to the visual centers in the brain.

The technology being used to develop the artificial retina will be directly relevant to devices that would be used to correct deficits in other parts of the nervous system. All sensing and stimulating devices need durable, flexible, and biocompatible materials. The composition and architecture of the optimum stimulating electrode may be the same throughout the nervous system. Packaging, sealing, and powering needs for one device will be applicable to others. Devices will differ according to the sensory or motor function they are constructed to restore.

I am asking the Biological and Environmental Research Advisory Committee (BERAC) to establish a subcommittee with broad expertise in the development and use of neuroprostheses and am charging the BERAC to provide me with advice on the following questions:

- Does BER have a role in the development of fundamental technology in the field of neuroprosthesis research?

  In what areas of neuroprosthesis research, e.g., material sciences, microelectronics, and telemetry, etc., can BER make its largest impact?

- Given the expertise and resources of BER, and the capabilities of the National Laboratories, what neurological defects and types of devices should BER focus on? Examples of specific research areas might include spinal cord paralysis, deep brain stimulation for Parkinson's disease, machine/brain interfaces to control prostheses, and others.

I would urge members of the BERAC serving on the subcommittee to enfranchise additional scientists on the committee if necessary. Dr. Viola and other members of the Medical Sciences Division involved in the Medical Applications Program are eager to work closely with you and your colleagues in any way that you see fit on this challenging topic.

I look forward to receiving your initial findings and your recommendations at the next BERAC meeting on November 3-4, 2004.

Sincerely,

Raymond L. Orbach
Director